

PERSONALIA

PACS number: **01.60.+q**

Vladimir Ivanovich Ritus (on his seventieth birthday)

On May 23, 1997, Vladimir Ivanovich Ritus, an outstanding physicist and a Corresponding Member of the Russian Academy of Sciences, marked his 70th birthday.

He was born in a family of research workers of the Timiryazev Agricultural Academy, Moscow. He joined the community of theoretical physicists in an unusual way. After he had successfully finished the preparatory division and first-year course of education at the Moscow Aviation Institute (MAI), Ritus determined to enter the first course of the Faculty of Physics at Moscow State University (MSU), specializing in nuclear physics. That was in year 1945, a year of exciting advances in theoretical and experimental nuclear physics, which culminated in the first nuclear explosions. It was therefore easy to see why the young man found new interests. Still, his first attempt to make his wishes come true failed. As the reason for his refusal, the University's rector wrote on Ritus's application: "I don't feel it possible to accept a successful MAI student. A typical case of delay in specialist training." However, everything had a happy end owing to Ritus's reasonable insistence. He carried out his diploma project under the guidance of I Ya Barit, a talented experimental physicist, in I M Frank's laboratory at the Physical Institute of the USSR Academy of Sciences (known as FIAN for short in Russian). The project evoked the strong interest of I V Shtranikh and F L Shapiro. In this work, probably for the first time in this country, a system of scintillation counters was constructed and the angular correlation of cascade γ-quanta of several nuclei was measured. In January 1951, Ritus was admitted to a post-graduate course.

However, unforeseen circumstances soon changed the natural course of events. By a special decision, the government ruled to set up a team to work on thermonuclear weapons, and Ritus was 'pulled out' of the post-graduate studentship and sent to the 'installation' where he was to join I E Tamm's and A D Sakharov's group. Working with these remarkable persons, Ritus was engrossed in complicated scientific and applied problems and did much to resolve them. This won him a USSR State Prize in 1953.

About two years after the Soviet Union had built and tested its first H-bomb, Tamm was able to return Ritus to FIAN's Theoretical Department he headed. Soon, Ritus reported in the *Zh. Eksp. Teor. Fiz.* his first unclassified studies which he had begun at Tamm's suggestion at the 'installation'. The studies were concerned with the theory of pion photoproduction and the scattering of photons on nucleons with regard to isobaric states. This choice of studies had been induced by Fermi's pion – nucleon interaction experiments which revealed the resonance behaviour of the

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scattering cross-section. Ritus derived angular polynomials – matrices which proved a very efficient tool for studying the polarization effects in nuclear reactions.

Even at that time, Ritus's scientific self-reliance, exceptional conscientiousness, and emphasis on quality performance won him the deep respect not only of his colleagues but of all those who were around him.

His candidate of sciences dissertation (1959) on the theory of reactions involving polarized particles could have made several dissertations. Its findings were cited in monographs by other authors, but it was not until 1971 that Ritus published it.

Ritus's doctor of sciences dissertation (1969) dealt with a different subject — quantum processes in strong external electromagnetic fields. This fundamental work had been the outcome of many years' strenuous effort, and nobody would have doubted its carrying enough weight for a doctor's degree, but Ritus did. His reward was his opponents'

Uspekhi Fizicheskikh Nauk **167** (5) 569 – 570 (1997)
Translated by B V Kuznetsov

praising reviews, especially the poetically rapturous one given by E M Lifshitz.

Turning to a more systematic account of Ritus's main scientific results, we should note that the probabilities he has found for the photoproduction of neutrino pairs on electrons are important in the analysis of the energy balance of stars and supernova explosions.

Together with A I Nikishov, Ritus derived probabilities of the main quantum-electrodynamic processes that take place in the field of a strong electromagnetic wave, namely, for the emission of a photon by an electron and for pair production by a photon. They showed that these probabilities could serve to approximately describe similar processes involving high-energy electrons and photons in any strong field. The point is that an ultrarelativistic electron in its rest system 'sees' any electromagnetic field almost as the field of a plane wave for which the solutions of the wave equations (the Volkov solutions) are especially simple. Experiments with a view to detecting the effects of nonlinear quantum electrodynamics predicted in this theoretical work are carried out now by a team of US physicists at the Stanford linear accelerator.

Later, Ritus carried out a detailed investigation of the influence of strong fields on decay processes involving several particles in the final state. The equations he derived, in this connection and others later, as well as his qualitative criteria have stood the test of time: if someone did obtain different results, the discrepancy would soon be found to arise from an error in the later studies.

Ritus was the first to realize that the Lamb shift in the levels of atomic electrons could be simulated by the shift in the energy levels of atoms in a laser-beam field. By introducing the important notion of quasi-energy, he was able to find the level shifts and splittings for the hydrogen atom.

In a series of studies concerned with radiation effects in the quantum electrodynamics of a strong field, Ritus obtained several remarkable results. They may be divided into two areas. One had to do with the polarization of vacuum by a strong field. It involved finding the two-loop Lagrangian field function. In evaluating it, one has to renormalize not only the charge, but also the mass of the electron. In the limit of a strong field, the resulting Lagrangian function exhibits renorminvariant properties identical to those of the polarization operator of a photon at large values of the momentum squared. In this way, a link was established between the quantum electrodynamics of strong fields and short-range quantum electrodynamics.

The other area encompassed studies into the motion of an electron in a strong field. It involved calculating the eigenvalues of the mass operator of an electron in a field. Specifically, Ritus found the shift and splitting of the electron mass in a constant uniform strong field and the behaviour of the anomalous magnetic and induced electric moments with variation of the field intensity and electron momentum. In particular, he discovered the remarkable transcendental dependence of the electron mass on the electric field ε, linear in the modulus of the electric force $e\varepsilon$ if its work on a Compton length is small in comparison with the rest energy of the electron:

$$\mathrm{Re}\,\Delta m = -\frac{1}{2}\,\alpha\beta m\,, \qquad \alpha = \frac{e^2}{\hbar c}\,, \qquad \beta = \frac{\hbar|e\varepsilon|}{m^2c^3} \ll 1\,.$$

This implies, firstly, that the shift at the point $e\varepsilon = 0$ is nonanalytic and nonperturbative in the field ε (i.e. it cannot be obtained using perturbation theory), and secondly, it has the classical limit in a weak field. The latter point is a significant, and evidently the first case, in which the classical limit of the quantum equations is not contained in the classical theory of the electron (in the Lorentz – Dirac equation). In these studies, Ritus used an original method of the electron mass renormalization and demonstrated that the shift of the electron mass in a strong field would show up detectably in pair production by the field. The diagonalization of the mass operator (the Ritus E_p-function method) has proved very efficient and is widely used now.

Equally unorthodox was the dispersion method he used to find the mass of a photon, the mass shift, and the anomalous magnetic moment of an electron in a strong field from the probabilities of pair production by a photon and the emission of a photon by an electron.

Jointly with V O Papanyan, Ritus determined the probability of photon splitting in a strong field. Together with D A Morozov, he analyzed two-loop corrections to the mass operator of an electron in a strong field. In collaboration with S L Lebedev, Ritus undertook a detailed study of radiation corrections to the probability of pair production by an electric field and interpreted them from a physical point of view.

The series of Ritus and Nikishov papers on quantum electrodynamics won them the I E Tamm Prize of the USSR Academy of Sciences in 1983.

Ritus, together with Nikishov, connected the Stokes phenomenon in the theory of asymptotic series to the formation zone of an exponentially weak process (pair production by a weak constant field).

In recent studies where he was studying the known analogy between the Hawking radiation of black holes and the radiation of an accelerated mirror, Ritus noted that the Bose and Fermi radiations of an accelerated mirror in $1+1$ space had the same spectra as radiations of electrical and scalar charges in $3+1$ space moving along the same trajectory as the mirror. He also proposed an ingenious derivation, free from divergences, for the energy-momentum tensor of a mirror's radiation and proved that this tensor differs from the force of radiation reaction of a charge in the classical Lorentz – Dirac equation only in the Doppler factor. Such analogies serve to give a deeper insight into the physical processes being compared.

Taken viewed on the whole, Ritus's scientific papers may be characterized as well-grounded and elegant.

Ritus is a member of several scientific councils and sits on the Editorial Board of the present journal. For several years he was the deputy director of the Tamm Division of Theoretical Physics. Although he does not like and avoids executive work, the new times call for assistance from new people.

His exceptional sense of responsibility in any undertaking, modesty, and self-criticism combined with his readiness and desire to give a helping hand, create a healthy climate around him. We sincerely wish Vladimir Ivanovich many years of productive work and in these hard times he helps us to see better what we are lacking and what we should be striving for.

M A Vasil'ev, V L Ginzburg, A V Gurevich,
G F Zharkov, N S Kardashov, L V Keldysh,
D A Kirzhnits, A I Nikishov, M A Solov'ev,
I V Tyutin, E L Feĭ\displaystyle, I S Shapiro